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Utilities' business models for renewable energy: A review

Mario Richter*

Centre for Sustainability Management (CSM), Leuphana University of Lüneburg, Lüneburg, Germany

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ABSTRACT

The transformation of today's electric power sector to a more sustainable energy production based on renewable energies will change the structure of the industry. Consequently, utilities as the major stakeholders in this transformation will face new challenges in their way of doing business. They will have to adapt their business models to remain competitive in the new energy landscape. The present review of business model literature shows that two basic choices exist: utility-side business models and customer-side business models. The two approaches follow a very different logic of value creation. While the former is based on a small number of large projects, the latter is based on a large number of small projects. The article reveals that blueprints for utility-side business models are available, whereas customer-side business models are in an early stage of development. Applying the business model framework as an analytical tool, it is found that existing utility-side business models comprise a series of advantages for utilities in terms of revenue potential and risk avoidance. This study provides new insights about why utilities will favor utility-side business models over customer-side business models and why they also should engage in customer-side business models in their quest for more sustainable future business models.

Contents

* Tel.: +49 17626392486; fax: +49 41316772186.
E-mail address: Mario.Richter@uni.leuphana.de

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1. Introduction

About 82% of the worlds' electric energy supply is either based on fossil fuels like coal, gas, and oil or nuclear energy [1]. The production of electricity supply accounts for the largest share of the world's anthropogenic greenhouse-gas emissions, while the use of emission-free nuclear energy comprises serious security risks and unsolved problems of hazardous waste [2]. Renewable energies are seen as the most important instrument to mitigate climate change and reduce negative effects of energy production [2,3]. This has led governments in the United States and Europe to re-think their energy strategies and to formulate greenhouse gas reduction targets, renewable portfolio standards and accordant regulatory frameworks. Consequently, the energy industry in the United States and Europe stands at the beginning of a huge transformation process [4,5].

The increasing share of renewable energy sources is expected to change the structure of the energy sector [6]. The centralized production and distribution network is increasingly confronted with distributed small scale renewable energy technologies. This development will have an impact on the way how energy is produced and distributed to the customer [7,8]. Due to their dominating position in the electricity sector, utilities will be confronted with disruptions of their current way of doing business and face the challenge to develop new business models for electricity generation from renewable sources [9,11]. How utilities design and operate their business models for the increasing use of renewable energies is pivotal for the future of the utilities and the entire energy industry. Consequently, the guiding question of this work is: *how do utilities shape their business model for renewable energies?*

The present paper has been inspired by studies applying the business model concept to the field of renewable energies [12,13]. The aim of this paper is to review the current state of the literature on utilities' business models for renewable energies. By applying the business model concept as a structural framework for analysis, this study offers new insights on the challenges and chances for utilities. The objective is to help utilities to review their current activities and adjust their business models to renewable energies. The findings can help utilities to develop new ways of value creation and thus contribute to the implementation of clean energy technologies and the path to corporate sustainability [14,15]. Furthermore, the results offer insights for policy makers in the field of energy.

The paper is organized as follows: Section 2 reviews the business model literature to derive an analytical framework for this study. Section 3 draws on the existing literature on utilities' business models for renewable energies and derives two generic business models that are subsequently analyzed in detail to identify the main challenges, existing innovations and open questions. Section 4 discusses and compares the two business models. Conclusions are provided in Section 5.

2. Analytical framework

The energy transition is a strategic challenge for utilities. Corporate strategy is concerned with the competitive environment of the corporation. It deals with the analysis of the competitive environment, the definition of the position in the market, and development and maintenance of competitive advantage [16,17]. At the same time, every enterprise either explicitly or implicitly employs a particular business model, which describes the design of the value creation, delivery and capture mechanisms [18]. In contrast to strategy "*the essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit*" [18,p. 172]. Basically it is the "*the rationale of how an organization creates, delivers, and captures value*" [19,p. 14]. The literature on strategy and business model is closely related. In this paper however, the business model is used as analytical framework, because the energy transformation is primarily concerned with questions of value creation and value capture for utilities.

Table 1
The business model conceptualization.

Business model pillar	Description
Value proposition	The value proposition describes the bundle of products and services that create value for the customer and allows the company to earn revenues.
Customer interface	Customer interface comprises the whole contact with the customer. It comprises customer relationship, customer segments, and channels.
Infrastructure	The infrastructure describes the architecture of the company's value creation. It comprises key resources, key activities, and key partnerships.
Revenue model	The revenue model describes the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to the customers.

Source: Based on [19,26].

Authors agree that the business model is a valuable tool for analysis and management in research and practice [20–22]. And it is pointed out that this is especially true for industries undergoing fundamental changes [16,23]. In terms of analysis, the business model concept enables the examination and comparison of markets and companies in a structured way, thus, providing the basis for the identification of critical success factors [24]. Using the business model concept as classifying device provides business mangers with valuable ways to expand their understanding of business phenomena by building generic categories and the development of ideal types [25]. Hence, the business model helps managers to capture, visualize, understand, communicate and share the business logic [26]. Furthermore, business models can function as "recipes" or "blueprints" that are ready for copying or variation and innovation [25].

Despite the increasing importance of the business model concept in the academic literature there is no generally accepted definition [27]. However, a review of the literature shows that many business model definitions are based on four basic elements: value proposition, customer interface, infrastructure, and revenue model [23,26,28,29].

The *value proposition* describes the products and services that are offered to the customers [21,29]. The *customer interface* describes the interaction with the customer [19]. The *infrastructure* comprises the companies' activities and assets required to create the value proposition, thus the internal organization of the value creation process [29]. Finally, the *revenue model* represents all revenues and costs associated with selling the value proposition [19,21,23]. Building on this literature review the present study is based on the business model conceptualization and terminology of Osterwalder and Pigneur who provide a coherent and robust framework (Table 1).

Osterwalder and Pigneur's conceptualization of four basic elements offers some advantages: first, the concept has been extensively tested in practice. Second, it is easy to apply. Third, it has already been successfully applied to the field of renewable energies [13].

3. Utilities' business models for renewable energies

3.1. Background

3.1.1. Current state of the literature

Renewable energies have not been of much interest to most utilities so far [10]. However, this situation is changing rapidly [30,31]. Recent polls among utility executives show that the companies see themselves confronted with fundamental changes arising from new technologies, changing policy requirements, and higher customer expectations [32,33]. When asked about the most important topic in the industry in the coming years utilities clearly rank renewable energy technologies over all other issues. Renewable energy technologies are expected to have the greatest potential for disrupting the current energy system [32,33].

Authors on utilities' business models for renewable energy widely support this view by stating that finding approaches to serve customers with less and cleaner energy requires a fundamental rethinking of how utilities produce, transmit and sell electricity [5,9]. Regulatory actions like the formulation of greenhouse gas reduction targets or renewable portfolio standards have already created impact on the energy industry. Further development in the regulatory framework to foster large scale deployment of renewable energies can be expected [34]. Considering the looming changes in the energy sector the authors point to the importance of viable business models to master the challenges ahead [35]. For example, Gordijn and Ackermans [36] note that creating a viable business model is the perquisite for economic sustainability of new technologies in the market beyond their research and development stage. Duncan [9] sees economically sustainable business models as the crucial linchpin for large scale deployment of renewable energy technologies.

Currently, in the most widespread business model for renewable energy in the American and European markets, the customer or a third party owns and controls the renewable energy system [37]. The utility provides connection to the grid and is obliged to purchase the electricity. As compensation for these services the utility is allowed to pass the costs on to the consumer [38]. In this situation there is no economic benefit for utilities, because passing through costs for power purchase agreements usually do not contribute to utilities earnings [38,39]. Even more, authors argue that there is a threat to utilities: an increasing share of renewable energy systems owned and operated by customers would lead to decreasing electricity demand and consequently erosion of revenues for utilities [6,8–11,39,40]. While there is unity on the fact that utilities need to develop new business models for producing, delivering and selling energy, there is no clear picture of how the successful business model of the future will look like [38]. Still, some first insights suggest that ownership of renewable energy assets and new energy related services will play an important role for utilities.

Frantzis et al. [10] propose that *ownership of renewable energy assets* is the most promising path for utilities, because it offers the largest return potential. This way the utility can earn a return on the asset and also benefit from operation services [37,39]. To date, utility ownership of photovoltaic and concentrated solar power projects has been limited in the United States, because some states have prohibited utilities from owning and operating distributed energy resources [10,41]. In October 2008, however, the U.S. federal solar investment tax credit was renewed and included a provision that now allows investor-owned utilities to monetize the tax credits [41]. Recently a number of American utilities started business with distributed solar power plants [37,41]. In Europe, however, utility ownership of renewable energy is generally accepted and has strongly increased for several years now.

Another frequent finding is that utilities need to develop from commodity providers to *energy service providers* [6,8,42]. The idea is that utilities should evolve to comprehensive energy-solutions providers for residential and commercial customers to create new sources of revenues. These new energy solutions and services could be based on distributed renewable energy, energy efficiency, and new technologies like smart grids and demand side management [43]. Utilities could also enter the retail business and provide customers with renewable energy systems [6].

The present study builds on these findings by assuming that the utilities own the renewable energy assets and by carefully considering the potential of new energy services for additional value creation.

3.1.2. The electricity value chain

In order to find out how a new business model for renewable energies should look like, it is important to first understand the utility's current business model. Schoettl and Lehmann-Ortega [11] point to the fact that utilities first need to decide in which part of the value chain they want to engage before entering the development of new business models. Therefore, this article starts out with a glance at the electricity value chain, because this is where they have to start from when developing new business models for renewable energy (Fig. 1).

Generation of electricity means the transformation of primary energy resources into electric power [44]. The largest share of electricity in industrialized countries is generated in large scale power plants based on fossil fuels and nuclear energy [1]. The generation assets are mainly owned by a small group of utilities. Despite some challenges like the fluctuating nature of renewable sources renewable energy is seen as a substitution of conventional power plants in the long run. Acknowledging ambitious governments' targets it can be said that today's generation capacity will be largely replaced by renewable energy technologies within the coming decades.

Transmission comprises the transport of electricity at high voltage over long distances via the transmission grid. The transmission system operator (TSO) handles the balancing of electricity supply and demand in his area. Even if numerous TSOs are active in the market, the transmission grid usually is a natural monopoly in its area. Today's transmission system is designed to deliver energy from a few central production points to a large number of customers. Since electricity supplied by large scale renewable energy plants like offshore wind farms are usually not close to the centers of consumption, new transmission grids are required. Additionally, the fluctuating nature of renewable sources requires a more flexible transmission network.

Distribution networks are designed to deliver electricity to the end customers at low voltage level. The distribution network usually has only few connection points to the transmission grid and different distributions networks are only connected among each other via the transmission grid. If power plants are directly connected to the distribution grid, they can mainly be controlled by the distribution network operator (DSO), but the TSO ultimately decides in matters of overall grid stability. The DSO is responsible in all matters regarding the connection of end users to the grid [44]. Since customers now become energy producers themselves and an increasing number of renewable energy projects will be connected to the grid, energy and information will flow in two directions. This creates the need for new flexibility in the distribution network.

Retail can be considered a mainly administrative task that includes the communication with the end customer. Retailers purchase power from producers, traders, or an exchange and sell it to end customers. Retail mainly includes purchase of electricity, metering and billing. With an increasing number of customers producing their own electricity from renewable resources, retail has



Fig. 1. The electricity value chain.

to find ways to counter the erosion of revenues and develop new offers for customers.

Consumption of energy takes place on the customer-side of the meter. It is expected that the energy transition will change customer segments and communication channels. The consumers will likely take a more active part by being energy producers themselves [8]. This leads to the change that energy is not only consumed behind the customers' meter, but it will also increasingly be produced.

To sum up, the view on the traditional electricity value chain shows that large scale deployment of renewable energies will change the way how energy is produced and how it is distributed to the customer. An impact will occur on every step of the conventional electric energy value chain. As this section focused on the initial situation, the following section takes a look at the opportunities and challenges associated with the energy transition.

3.1.3. *Two generic business models for renewable energies*

The analysis of the electricity value chain showed that new ways of doing business are required in several fields. As far as electricity production is concerned, two sections of the electricity value chain are of importance: generation and consumption. Generation is the classical step in which the electricity production takes place. Here the production has to change from the conventional source to renewable energy sources. What is new is that renewable energy enables consumers to become energy producers as well. This means production now also takes place in the consumption section. Referring to this distinction two generic business models can be derived from the literature: a *customer-side renewable energy business model* and a *utility-side renewable energy business model* (Fig. 2).

Customer-side renewable energy business model: In this business model the renewable energy systems are located on the property of the customer. Possible technologies are photovoltaic, solar thermal hot water, CHP micro power, geothermal heat pumps, and micro wind turbines [45]. The size of the systems usually ranges between a few kilowatts and about 1 MW. The value proposition offered by the utility can range from simple consulting services to a full-services package including financing, ownership and operation of the asset [6,9,10]. Utility financing and ownership of customer-side assets intensifies the customer relationship and can provide access to new customer segments, of customers who otherwise could not afford installation of renewable energy systems [9]. As far as the utilities' architecture of value creation is concerned, a management approach for small scale projects is needed [11]. The revenues for the utility come from return on the assets and charge for services, while costs arise from administration, installation and operation of the systems [39].

Utility-side renewable energy business model: In this model, the projects are larger than customer-side projects and range from one to some hundred megawatts. Typical technologies are on- and offshore wind farms, large scale photovoltaic projects, biomass power plants, and solar thermal power plants [6,11,39]. The value proposition in this business model is bulk generation of electricity that is fed into the grid [39]. Therefore, the customer interface consists of power purchase agreements on a business to business level, rather than a relationship to the end-customer. As far as the infrastructure is concerned, these projects are much more similar to traditional centralized power plants than the customer-side business model. They are much closer to the utilities' core competency of asset management and operation [11,39]. Costs arise from construction and operation of the energy project, while revenues come from regulated feed-in tariffs for electricity or tax- or investment credits.

The two generic business models are "ideal types" and represent the two sides of a spectrum [25]. Of course these ideal types cannot fully reflect the reality, but they provide a ground for the analysis of two very different fields of business.

3.2. *Customer-side renewable energy business models*

The growing availability of renewable energy systems which can be installed in private households or commercial environments enables home owners and enterprises to participate in electricity production [46,47]. It is expected that these technologies could play a substantial part in meeting electricity needs, meeting greenhouse gas reduction targets, and increasing energy security [48,49]. As pointed out, it is concluded that increasing ownership of renewable energy sources by third parties will lead to loss of market share and profit erosion for utilities [6,10,40]. Therefore, the increasing share of third party owned renewable energy systems requires utilities to think about how they can benefit from this development. Customer-side renewable energy business models offer the chance to turn the threat of revenue erosion into an opportunity for new ways of creating and capturing value. This section reviews the current challenges of utilities to build new business models around renewable energies on the customer side. The analysis in this section follows the four basic business model elements introduced earlier: value proposition, customer interface, infrastructure, and revenue model.

3.2.1. *Value proposition*

The value proposition describes the bundle of products and services that create value for the customer and allows the company to earn revenues. The classical utility's value proposition comprises production and delivery of electricity for a fixed price per kilowatt hour. Electric power is considered a commodity, sold without qualitative differentiation. With few exceptions the demand for electric power rose continuously over several decades. This can be explained with the increasing standard of living throughout the United States and Europe, allowing utilities to grow revenues on an almost constant basis for a long time [8]. However, several authors on business models for utilities expect that with increasing shares of distributed (renewable) energy generation, energy efficiency measures, and smart energy applications the classical value proposition is no longer a foundation for further growth of electric utilities [6,38,42]. From this insight authors conclude that utilities need to develop new value propositions to maintain competitiveness in the changing energy landscape. In this context it is often argued that electric utilities need to develop from simple commodity suppliers to comprehensive energy solution providers [6,9,10]. Potential energy solutions could include services such as consulting, installation, financing, operation, maintenance, and warranties.

One example for how financing services can be designed is provided by Public Service Electric & Gas Company (PSE&G). New Jersey's largest utility offers a Solar Loan Program, providing financing for solar energy systems on homes, businesses and municipal buildings throughout its electric service area. PSE&G finances between 40% and 60% of the investment costs. The benefit for the customer is that unlike bank loans, which must be repaid in cash, Solar Loans can be repaid using Solar Renewable Energy Certificates. The certificate is a clean energy credit issued in the form of a tradable certificate by the New Jersey Board of Public Utilities.

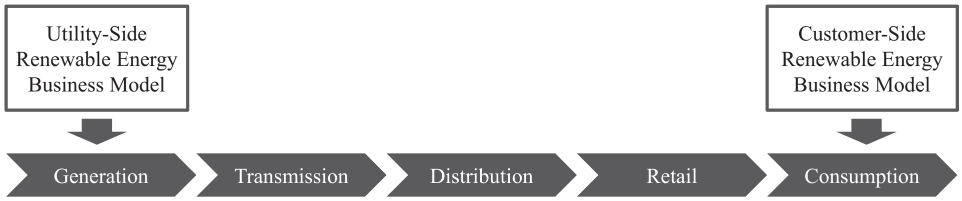


Fig. 2. Two generic business models.

Every time the solar power system generates 1000 kWh of power, one certificate is earned. The benefit for the utility comprises the interest and the fact that this way the costs such as program administration, advertising, and meter installation would be treated as regulatory assets included in the utility's rate base, which means that a return can be earned on these [39,50].

The Texan utility Austin Energy is considering plans to go beyond particular services like financing or consulting. Austin Energy's vision is offering a fee-based energy service: customers would become active "energy partners" rather than passive ratepayers. The customer would sign a service contract for a fixed cost per month. For this fixed price the costumer gets all power he needs, within a tested and predetermined range. The partnership agreement stipulates that the customer agrees to make his roof available for solar devices owned by the utility and to participate in the demand-response program. In this business model Austin Energy owns the solar systems and, thus, earns a return on the assets which is favorable following Nimmons and Taylor [39] and Frantzis et al. [10]. Further benefits can be reaped from steering customer demand via the demand-response program. It has to be emphasized that this idea has not been tested in practice yet [9,12].

The examples of new value propositions presented in this section are based on the idea that utilities need to benefit from customer-side renewable energies and that utility involvement could foster the deployment of renewable energy systems, because the up-front investment and the time and effort for the home owner is taken over by the utility. The main problem of these new value propositions is to reach a sufficient level of profitability for the utility. Given the comparatively small investment volumes of individual energy systems the price and the return potential on a single offering like consulting services is limited. For this reason a report by Austin Energy points to the fact that it is necessary to create service packages because individual services are not profitable enough [42]. This approach increases the overall return generated from one customer. But still, the utility has to provide a series of services that have not been offered to customers so far. To date, utilities have kept contact to the individual customer as limited as possible to reduce transaction costs per customer. These new value propositions require significantly higher effort with the individual customer and thus lead to higher transaction costs per customer. The analysis of examples in this section indicates that new value propositions are at a very early stage of development [37]. The real costs and revenue potential of these value propositions are still unclear to most utilities [42]. The value proposition for the customer-side renewable energy business model has yet to be defined and utilities are still uncertain what can be profitable in the long run.

3.2.2. Customer interface

A recent study among 9000 end consumers in 22 countries revealed that consumers increasingly voice their concerns over security of supply, energy costs and climate change [51]. Furthermore, the study indicates that there seems to be a lack of trust towards utilities. Consumers do not trust energy companies to deliver the required changes alone and are calling on government to take a more active role in guiding energy matters [51]. Customers often seem to mistrust utilities and express the feeling that the energy suppliers are not interested in informing them honestly about green energy options. For example, Press and Arnould [52] explain that consumers often support renewable energy but hesitate to buy green electricity because of a lack of transparency. With peoples' growing interest and mistrust and the need to develop new value propositions on the customer side of the value chain, however, the need for increased efforts for good management of the customer interface becomes obvious. An improved customer interface management, comprising *customer relationship*, *customer segmentation* as well as *channels* offers possibilities for utilities [19].

To find out what customers think and expect is the task of *customer relationship* management. Hence, a good customer relationship management is of utmost importance for developing new value propositions. For example, the customer survey by Accenture [51] reveals that concerns about issues vary between different countries, but some 89% of the participants worldwide are convinced that their countries need to reduce dependence on fossil fuel based electricity production. The majority wants a more sustainable power production through the development of low carbon energy sources, rather than doing efforts by changing lifestyles. Consumers prefer supply-side efforts to reduce the environmental impact of energy production. To foster these efforts greater government intervention in the energy market is often demanded [51]. While customer relationship has not played an important role for utilities so far, the increasing share of decentralized energy production makes the customer relationship more complex [40]. Customers' expectations are rising and the needs tend to become more diversified. To adequately address these issues and reduce the risks of such developments, utilities need a more active customer relationship management.

Customer segments define groups of people or organizations an enterprise aims to serve with its value proposition. These customer segments are changing with the increasing use of renewable energies. While many consumers demand efforts from utilities, an increasing number of consumers starts to produce energy with distributed energy appliances [40,51]. Authors expect the customer base to become far more heterogeneous than it is today [40,42,51,53]. Knowledge about the different segments is necessary for utilities to develop new value proposition that actually meet the customer demand. For example, while active consumers could be interested in financing models for distributed energy devices, passive consumers could be more interested in a flat rate tariff for electricity consumption. New products and services can be tailored to the needs of one specific customer group [54]. Identifying customer segments and their specific needs is a prerequisite for successful development of new value propositions and business models. It is also a prerequisite for an appropriate customer relationship management.

The *channel* describes how a company communicates with its customers and how it reaches the different customer segments in order to deliver the value proposition. To date, the need to address channels to raise customers' awareness of products and services has been limited for utilities. With the transformation from commodity provider to an energy service provider the channel becomes

more important for utilities. New service-oriented business models require a better exchange of information between utility and customer. For example, smart home systems or demand side management require a two way flow of information. The customer is provided with exact information on his consumption which enables him to actively manage his usage. The utility uses the data for load management and development of new value propositions and pricing mechanisms. Access to relevant customer-related data will be crucial to be able to design and capitalize on new business models [40].

Overall, active customer interface management has played no significant role for utilities so far. But in the changing energy landscape it becomes essential, because of increased customer expectations and new value propositions. Segmentation helps to identify customers' expectations and needs and it provides the basis for successful new value propositions and business model innovation. Channels become a critical resource for utilities, because flows of information are getting more important and complex with new service offerings. Finally, customer relationships turn out to be more relevant as the value creation tends to be closer to the customer. To conclude, a good customer interface management is a prerequisite to successfully manage and communicate the changes in the business model.

3.2.3. Infrastructure

The infrastructure describes the internal architecture of the firm's value creation. This means it describes the way it creates the value proposition and delivers it to the customers. The infrastructure comprises three elements: *key resources*, i.e. the power plants to produce electricity and the grids to deliver it to the customers, *key activities*, i.e. the most important processes, and *key partnerships*, i.e. cooperations or joint ventures with other companies [19]. The infrastructure of the energy sector has remained mainly the same for many decades [8]. But new value propositions based on small scale renewable energies on the customer-side require a new infrastructure in terms of energy production and delivery. For utilities this means new key resources, new key activities, and new key partnerships.

Key resources are the most important assets required to produce the value proposition. Key resources in the energy sector are at foremost the generation units. In the traditional utility business model the key resources are centralized conventional power plants. In the customer-side business model the generation assets are for example photovoltaic solar systems installed on the customer's roof. Owning and operating a large number of decentralized renewable energy systems would lead to a fundamentally different structure of the key resources than in the traditional utility business model. The installation and operation of a large number of energy systems in dispersed locations leads to higher transaction costs per megawatt of installed capacity. The new key resources also require fundamentally different key activities.

Key activities comprise the most important things a company must do to make its business model work. For example, key activities are the production of goods or services. The traditional key activity of utilities in the field of electricity generation is asset management and operation [11]. With a large number of small decentralized generation assets on the customer-side, utilities need to develop new approaches in the field of asset management and operation. Also, as pointed out, new activities in the field of customer interface are necessary to develop such a business model. How exactly the key activities should look like depends on the size and the competencies of each individual utility. For example, large multinational utilities tend to be fully integrated, covering all parts of the value chain in order to capitalize on economies of scale while smaller utilities often focus on distribution and retail and do not operate their own production facilities [43,55,56].

Key partnerships mean the network of suppliers and partners that make the business model work. Key partnerships are designed to find a solution to a certain problem the company cannot or does not want to solve alone. They can help utilities to compensate for resources or assets they do not posses. Utilities might enter into partnerships with manufacturers of renewable energy systems, such as solar photovoltaic systems, to provide customers with cheap systems and benefit from economies of scale. They could partner with installation companies like local service technicians if they do not want to hire own staff in this field. Partnership formation can be a valuable entry strategy into new markets.

To sum up, extensive innovation is necessary in the field of infrastructure to realize the transition from the traditional to the customer-side business model. The conventional power plants need to be replaced by renewable energy technologies. Consequently, new approaches to asset management and operation are necessary. Key resources and key activities in the customer-side renewable energy business model are very different from the resources and activities in the traditional utility business model. Key partnerships can help to include external expertise to realize this change process.

3.2.4. Revenue model

The revenue model describes the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to the customers. To date, utilities' revenues are usually based on a fixed price per kilowatt hour. This means that the more energy is consumed the better it is for the utility. The current revenue model therefore creates a disincentive for utilities to engage in energy efficiency or third party owned decentralized power generation, because thereby demand decreases and reduces revenues. Duncan [9] argues that the current revenue model is the greatest obstacle between the current utility structure and a modernized energy delivery system based on renewable sources. If utilities want to develop new business models to benefit from the increasing share of decentralized renewable energy a new, economically viable revenue model is required. Three main approaches are discussed in the context of utility's electricity sales: decoupling sales volume and revenues, dynamic pricing and flat rate tariffs [42,57].

Decoupling means dismantling the relationship of sales volume and revenues. Particularly, it means separating the utilities fixed cost recovery from the amount of electricity sold. Decoupling mechanisms have been considered mostly in the energy efficiency context, but they are also relevant to customer-side renewable energy [39]. Decoupling is a regulatory tool that can help to eliminate the disincentive for utilities to engage in customer-side renewable energies. While not widely accepted, the mechanism finds its way into the regulatory environment in some states in the United States [57]. By breaking the link between sales volume and revenues, the utility shall be motivated to focus on its customers' energy service requirements and not just on increasing sales volume. Critics of the concept argue that it promotes mediocrity in utilities. The utility is protected from declines in revenues at the taxpayer's expense. The success of decoupling strongly depends on the exact design of the regulation, but it is expected that the mechanism will increase in importance in the coming years [57].

Dynamic pricing means not defining a fixed price per kilowatt hour, but applying a flexible price which is orientated at the wholesale price of electricity. The extreme form would be real-time pricing based on wholesale prices. A moderate form is time-of-use pricing, for example with peak, and off-peak rates. Electricity is cheaper at night when less energy is consumed and more expensive at peak times during the day. This would give the customer price signals to reduce consumption and to shift load to lower-cost times. The benefit for utilities is a reduced peak load which leads

to lower back up capacity requirements and lower grid capacity requirements at peak times.

Flat rate tariffs mean the utility charges a fixed price regardless of the amount of energy consumed by the customer. To contribute to saving energy and fostering the use of renewable energies the contract needs to contain mechanisms to reduce the energy consumption of the customer. The idea behind this approach is to see the utility not as a rate charging commodity supplier but as a fee-based service provider. Consider the example of Austin Energy. A published report on the utilities' future business model recommends the exploration of a flat rate tariff that provides customers access to energy at a set monthly fee in exchange for participation in new efficiency and energy management programs. Customers would enter into a partnership with the utility that includes pre-determined time of use parameters, the installation of energy management equipment, programmable appliances, efficiency upgrades, and a utility option to use the customer's roof for distributed generation. This way the utility has an incentive to motivate the customer to save energy. The flat rate could be based on a per-square-foot basis. At least initially, participation should be voluntary. Usage outside the parameters of the agreement would be priced separately, much like "excess minutes" are charged to customers who exceed their cell phone usage plans. Those who choose not to participate in the flat rate partnership program would be subject to rates that reflect the utilities costs without the cost-savings efforts [42].

The revenue model consists of revenue streams and *cost structures*. The cost structure of the customer-side renewable energy business model has been rarely addressed in the literature. The new value propositions currently discussed (see Section 3.2.1) comprise a significantly higher and more individual effort per customer than in the conventional business model. In recent decades the costs of electricity production have been characterized by economies of scale in increasingly large power plants [8]. In the customer-side business model the cost structure will be fundamentally different, since new costs arise for each customer energy system. These higher transaction costs lead to lower profits for the utility or higher prices for the customer. On the other hand economies of scale might be realizable to a certain extend when a large number of customer-side projects are installed in a standardized way [37].

Creating new revenue streams from new value propositions is the essential task for utilities to maintain profitability in the future energy landscape. It is an important but difficult task for utilities as first pilot projects for customer-side renewable energy indicate [42]. Some new pricing mechanisms are currently tested by pioneer utilities, but overall the development of new revenue models is still at a very early stage. Extensive testing will be necessary to develop feasible new revenue structures that allow the shift from a volume-driven commodity provider to an energy service provider. The same is true for the cost structure which is still unclear today. However, it is clear that the distributed assets comprise significantly higher transaction costs per customer. The question is whether these can be recovered by new revenue streams. The composition of future revenue and cost structures still has to be determined.

3.3. Utility-side renewable energy business models

The growing political pressure from renewable portfolio standards and looming economic consequences from emission trading systems lead utilities to think about the use of alternative sources of energy production [5,43]. To substitute the existing infrastructure and reach significant percentages of the production portfolio, utilities are starting to invest in large renewable energy projects like on- and offshore wind farms, biomass and biogas power plants, as well as large scale solar power projects. These are typically larger than customer-side projects and range between 1 and some hundred megawatts. The main difference is that they feed electricity exclusively into the grid and are not located on the property of the customer. Projects that fall into this category are referred to as utility-side renewable energy business model in this study, or interchangeably as large scale projects. The developer or investor of such a project, in our case the utility, typically establishes a special purpose entity that comprises the tangible and intangible assets of the project. This structure is the usual way to own and operate a large scale renewable power project [58]. Nimmons and Taylor [39] note that these projects are much more similar to traditional power plants in terms of centralization and scale. Since these large projects provide bulk power to the grid, they do not displace customer retail purchases and do not present revenue loss concern for utilities [39]. The details of the utility-side renewable energy business model are analyzed in the same way as the aforementioned customer-side business model following the four business model elements: value proposition, customer interface, infrastructure, and revenue model.

3.3.1. Value proposition

The classical value proposition of the utility, i.e. the product or service offered to the customer, is generation and delivery of electricity for a fixed price per unit. In the traditional utility business model the power has been produced in conventional power plants based on fossil fuels or nuclear energy. In the utility-side renewable energy business model the electricity is produced in large scale renewable energy projects and subsequently delivered to the end customer. The value proposition in both, the old and the new business model is bulk generation of electricity that is fed into the grid [39]. Hence, the production of electricity from utility-side renewable sources does not force utilities to fundamentally change their value propositions as it is the case with the customer-side business model.

The general value proposition delivery of electricity remains identical. What changes is the quality of the value proposition. The electricity is produced more environmentally friendly, which can be considered a value added to the environmentally sensitive customer. Thus, utilities have the chance to capture more value from this new way of production. In practice many utilities benefit from the environmentally friendly produced electricity by offering green electricity tariffs with an "eco" price premium per sold unit [59]. For example, several German utilities offer such an "eco power" tariff. The company ensures that all the electricity sold under this tariff is produced from renewable sources. Furthermore it is guaranteed that the additional revenues from the higher price are used to invest in new renewable energy projects. This way, customers use electricity from renewable sources and contribute to the increase of clean production.

It can be concluded that electricity generation in large scale renewable energy projects does not require utilities to develop fundamentally new value propositions. Instead, it offers possibilities to enhance the value proposition by underlining the additional environmental value and creating ways to capture this value. Moreover, the new production methods can be used for marketing and public relations issues. All in all, the value proposition in the utility-side business model offers more chances and upside potential than requiring any risky or expensive changes in the product or service portfolio as with the customer-side business model.

3.3.2. Customer interface

The value proposition of utility-side renewable energy projects is feed-in of bulk electricity into the grid. The customers of this value proposition are not the end consumers, but are usually enterprises which transport and distribute the electricity to the end customer. Therefore, the customer interface consists of power purchase agreements on a business to business level, rather than a relationship to the end customer. Customer interface management

in the utility-side renewable energy business model plays a very different role than in the customer-side business model. This can be underlined by analyzing the three customer interface elements: customer relationship, customer segments, and channels.

The *customer relationship* consists of business to business relationships. The customers therefore mainly stay the same as in the traditional business model where operators of power plants sell the electricity to other companies via power purchase agreements or the electricity exchange. Consequently, there is no need for utilities to significantly change or improve the relationship towards the end customer to make the business model work. However, renewable energy sources are often used for marketing and public relation issues, because they provide a valuable argument to answer customer's declining trust and rising expectations towards utilities [30,32,51,60]. Consequently, the shift towards a more environmentally friendly way of production might help to improve the corporate image and increase customer's level of trust.

Customer segmentation is an important field for utilities to understand what customers expect from them. The creation of new green electricity tariffs requires knowledge on what portion of the customer base is willing to pay a premium for renewable energy [60]. But since the general value proposition does not significantly change, the change in the customer segments remains smaller than in the customer-side business model.

The *channel* towards the end-customer is not affected for energy producers. Electricity produced in large scale renewable power plants is delivered to the end customer via the existing grid infrastructure. Although it is expected that large shares of renewable energy will require improvements on the grid infrastructure, this is a question of new business models for grids, not for electricity production.

Overall, the required changes in the customer interface to establish a successful utility-side business model are somewhat similar to the value proposition: the customer interface can remain close to what it is under the conventional system, but rather can offer additional benefits to enhance the customer relationship. In terms of the customer interface, the utility-side business model offers more upside potential than threats to the utility.

3.3.3. Infrastructure

Following the business model conceptualization, infrastructure comprises key resources, key activities, and key partnerships necessary to create the value proposition. As far as the infrastructure is concerned, utility-side large scale projects are much more similar to traditional centralized power plants than the customer-side small scale projects [39]. Thus, they are much closer to the utilities' core competency of asset management and operation of large scale facilities [11]. A deeper look into the three elements of the infrastructure reveals that this business model element requires the largest changes compared to the conventional business model.

The *key resources* are the assets required to produce the value proposition and earn revenues. The most important assets in this case are the renewable energy projects. The share of electricity from renewable sources in utilities' production portfolios is still relatively low, compared to the ambitious portfolio standards formulated in many U.S. States and countries in the European Union. Thus, to reach the targets large parts of the conventional power production infrastructure has to be replaced by renewable energy projects in the coming decades. For example, Germany has formulated its goal to generate 80 percent of all electricity from renewable source until the year 2050. According to a recent study of the audit and consulting firm KPMG only the European offshore wind market requires investments of 141 billion Euro within the next 10 years to reach the national targets of 38.1 GW installed capacity until 2020 [61]. The replacement of existing key resources is one of the major challenges for utilities within the coming decades.

The *key activities* comprise those activities a company must do to make its business model work. Utilities have experience with large scale investment projects and have traditionally strong competencies in asset management and operation [11]. The technologies will be different and the projects will be smaller than in the conventional business model. Utilities' key activities regarding large scale renewable energy projects depend on the size and competencies of the individual utility. One possible approach for utilities would be to cover the whole project value chain. This approach allows the highest return on investment, because the utility is involved in every step of the value creation process. But covering the whole value chain does not necessarily make sense for all utilities. Larger utilities might benefit more from this approach than smaller ones due to their experience with complex and large scale projects [55]. For smaller utilities with only limited generation capacities it might not make sense to acquire the necessary competencies for all steps of the value chain [40].

In many cases utilities invest in turn-key projects they acquire from independent project developers [30]. Initiation and development is then taken over by the independent developer. These developers often also provide operations services to investors and maintenance services are provided by the manufacturer of the energy system. The utility would basically act as a financial investor and earn a return on its assets. However, it would not create and capture value from development and operation of the project. In general, vertical integration in the renewable energy value chain offers possibilities to increase the revenue potential for utilities. But this might not necessarily lead to an overall benefit for smaller utilities. Therefore, optimization of key activities is a major task for utilities to maximize value creation and capture from renewable energy projects.

Key partnerships mean the network of suppliers and partners that make the business model work. Key partnerships play an important role for utilities in the field of renewable energies, because utilities are often inexperienced this new field. Key partnerships provide a possibility to acquire knowledge and experience that is not available in the own organization. It is very likely the importance will increase further when more utilities enter into the field with substantial investment budgets [40]. The German market provides some innovative examples for valuable partnerships.

Cooperation with other utilities can help to make projects possible that otherwise could not be realized when a project is too risky or too large for one utility [61]. An innovative example is Trianel, a cooperative venture owned by 45 small and medium-size utilities. The company is designed to bundle individual strengths and investment volumes. The company plans a 400 MW offshore wind farm in the German North Sea with about 40 utilities. This offers the members an enormous added value, because they can diversify their portfolio with technologies in which they could otherwise not invest [62].

Another innovative example is cooperations or joint ventures between electric utilities and independent project developers. Juwi is one of the leading German project developers in the field of wind and solar energy as well as biomass. The company systematically enters into joint ventures with utilities to help them build up capacity in renewable energies. Juwi offers utilities the opportunity to cofound a joint company to realize renewable energy projects together. Each side is usually holding 50% of the shares in the company. Juwi brings in its expertise in project development and operations management of projects and the utilities bring in their financial strength to finance the projects and use the electricity. Other project developers are currently picking up the idea. This way, utilities can build up a portfolio of renewable energy production capacity without the need to establish an in-house department for project development. This might especially be interesting for smaller utilities which are too small to

economically employ project development specialists for only few projects.

Overall, the business model element infrastructure bears the largest need for adjustments for utilities in the utility-side business model. However, it also offers potential to increase value creation and capture. The replacement of conventional assets by renewable energies is a major challenge. Associated with this challenge is the need to define new key activities. The full potential of utilities key activities seems far from being fully captured. Key partnerships offer a valuable possibility to expand key activities. They are a rich field for further business model innovation. As the examples show, new forms of partnerships open new ways of value creation.

3.3.4. Revenue model

Utilities' investment decision for power projects are usually based on a well defined return expectation. The return expectations are calculated on the basis of so-called "financial models" that derive the return expectations from projected costs and revenues [63]. This approach is applied to conventional power projects and renewable energy projects alike. For large scale renewable energy projects costs arise from construction and operation of the energy project, while revenues come from regulated feed-in tariffs for electricity or tax- or investment credits.

Revenue models for large scale renewable energy projects and, thus, the utility-side renewable energy business model exist. "Templates" or "blue prints" are available in the market. The structure of these revenue models for renewable energy has been developed by investors over the last 20 years. Utilities can easily adapt these concepts to finance and operate large scale projects [64]. The traditional utility revenue model of charging the customer for a fixed price per kilowatt hour remains relatively stable. But as the previous sections showed, the revenue model for large scale projects offers room for innovation. First, green electricity tariffs or other approaches can help to increase revenues from environmentally friendly energy. Second, utilities optimize their activities in the project value chain and create new revenue sources from such activities as project development or service and maintenance. In this way, utilities use their competencies to extend the revenue model.

Revenue models for the utility-side business model exist and can easily be adapted by utilities. They do not require new structures like the customer-side business model revenue model. Utilities can build on proven models, which still offer room for innovation to increase value creation and capture.

4. Discussion

The generic customer-side business model for renewable energy and the generic business model for utility-side renewable energy follow a very different logic of value creation. While the former is based on a large number of small projects, the latter is based on a small number of large projects. Subsequently they provide very different challenges and opportunities for utilities' future development. Table 2 summarizes the key findings.

The customer-side business model is at an early stage of development. The development of this business model requires the creation of new value propositions. So far, it is difficult to reach profitability with the products and services currently discussed in the literature. That is why it is proposed to bundle new offerings to service packages. Due to the changing relationship with the customer, customer interface management becomes more important for the economic success of the utility. The infrastructure will dramatically change towards distributed small scale energy systems on the property of the customer. This creates a set of challenges and problems and requires a totally new approach to asset management and operation. Alongside with the new value propositions, another customer interface management, a new infrastructure, as well as new revenue models are required. So far, the comparatively higher transaction costs of small projects create problems with profitability. Today it is not clear if the customer-side business model can be economically sustainable for the utility under the current regulatory framework. This leads to a series of risks and limited opportunities for utilities.

The utility-side business model on the other hand is closer to the traditional utility business model and requires fewer fundamental changes in the way the utility does business. The value proposition does not have to be changed fundamentally, but offers room for additional value creation, e.g. from price premiums of "eco power". The same is true for the customer interface. As far as infrastructure is concerned, utilities need to adjust to new technologies, but can build on their core competency in managing large investment projects. The revenue model builds on existing templates and merely remains the same as before. To sum up, the utility-side business model offers a series of advantages over the customer-side business model.

Most studies on utilities' business models for renewable energy point to the threat of revenue erosion from renewable energies due to increased decentralized renewable energy generation by customers [9,10,40,43]. The proposed solution is to develop new business models for this field to benefit from this development. The present study acknowledges the severe threats for utilities from the energy transition in general, and the threat from customer-side renewable energy generation specifically. However, it adds to this discussion by pointing out that customer-side business models are not necessarily the best answer to the threat of revenue erosion from the utility perspective. The present review revealed that utility-side business models are practically developed and offer a series of practical and economic advantages for utilities, while customer-side business models are at an early stage of development and comprise open questions in terms of profitability. Therefore, utility-side renewable energy business models are more attractive to utilities in terms of risk and return expectations than customer-side renewable energy business models.

Given the increasing pressure from renewable portfolio standards to replace large capacities, the scarce know-how and the limited time available, utilities will mainly favor large scale projects, when considering risk return expectations and transactions costs. Hence, it can be concluded that customer-side renewable energy business models will remain on a small scale in the near future. However, the analysis also suggests the need to address customer-side business models for strategic reasons. Since it is not at all clear how the energy future will look like it is important for utilities to develop business models that are robust under different possible scenarios [4]. Utilities that start thinking about business model innovation early have the chance to develop new positions in the market and create sustainable strategic advantage.

The two generic business models also provide implications for policy makers. Since renewable energy is still dependent on government support, the business models in this field are directly dependent on the legal framework. From a political perspective, commercialization and large scale adoption of renewable energies is a major goal to reach corporate sustainability in the energy sector and energy security for the country. Utilities' business models are the linchpin to large scale deployment of renewable energy projects and therefore should be of interest to policy makers and researchers. This regulatory field offers the possibility to shape the further development of the energy landscape.

Using the business model concept as an analytical framework bears the risk of overlooking material aspects of implementation of those business models in practice as it is based on general observations. The analysis is on a generic level; specifics of individual companies have not been part of the analysis. Furthermore,

Table 2
Comparison of business model characteristics.

	Customer-side business model	Utility-side business model
Value proposition	Shift from commodity delivery to energy service provider	Electricity remains commodity-the value proposition basically remains the same
	New value propositions need to be developed	Additional value for the customer through more environmentally friendly production.
Customer interface	Better customer relationship is required to develop new value propositions	Relationship towards customers remains mainly unchanged
	Customer segments change	Customer segmentation allows to increase customer base and earn “eco” price premium
	New channels are needed	Channels mainly remain the same
		Chance to improve corporate image and rebuild trust
Infrastructure	Large number of small scale assets	Small number of large scale assets
	No experience with development and operation of small scale projects	Experienced in large scale infrastructure projects
	Partnerships with system suppliers and local installation companies	Partnerships with project developers and suppliers
Financial aspects	Revenue from feed-in and/or from services. Source and level of revenues unclear	Revenues through feed-in of electricity
	New revenue models need to be developed	Revenue models are available
	Cost structure becomes more complex due to many small instead of few large investments	Cost structures are in favor of utilities experiences with large scale infrastructure financing
	High transaction costs reduce profits	Economies of scale from large projects and project portfolios

Source: Own research.

the business model depends on the specific environment. Hence, detailed analysis on business models can only be derived for specific conditions and the results cannot be transferred easily to other settings.

The transformation process in the energy sector has just started and will continue for decades. The results of the present study provide a starting point for the development of renewable energy business models for utilities. The truly sustainable energy producer of the future is still far away which provides the need for further research in this field. More research is necessary to understand the implications of value creation under both business models. Hence, further studies should concentrate on the role of large scale renewable energy projects and small scale customer side projects from a business model perspective in more detail. An empirical foundation of the results of this study could enrich the debate on utilities' business models for renewable energies.

5. Conclusion

The analysis of two generic business models showed that large scale adoption of renewable energies requires utilities to think about their business model and how to adjust it to make the most out of the energy transition. It was found that the two generic business models have a very different logic of value creation. Utility-side renewable energy business models exist, while customer-side renewable energy business models are at an early stage of development. Moreover, the high individual effort and the small scale of customer-side projects leads to high transactions costs that lead to lower returns than with large scale projects. The difference in maturity and the role of transactions costs lead to the conclusion that utility-side business models have advantages over customer-side business models.

This study proposes that utilities should favor large scale utility-side projects over customer-side projects to reach renewable portfolio standards and reduce economic risks from carbon emissions. However, although the utility-side business models comprise less risks and promise better returns, utilities should consider customer-side business models for strategic reasons as well. The threat of revenue erosion from energy generation by customers might increase further. The market of small scale decentralized electricity generation might grow and offer significant new business opportunities in the future. To be prepared for these future developments, utilities should increase capabilities in the fields of innovation, business development and strategy to be able to react to market developments appropriately.

Policy-makers should closely follow the development of utility business models in the energy industry. Since renewable energy business models are highly dependent on the regulatory framework, policy-makers have direct influence on their future development. They should set the framework for a truly sustainable energy future.

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